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Arakane et al.

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(54) **CARRIAGE MOVING DEVICE, METHOD AND COMPUTER-READABLE RECORDING MEDIUM CONTAINING INSTRUCTIONS TO EXECUTE CARRIAGE MOVING METHOD**

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(51) **Int. Cl.**

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B41J 29/393	(2006.01)
B41J 2/015	(2006.01)
B41J 25/34	(2006.01)

(52) **U.S. Cl.**

CPC ***B41J 25/34*** (2013.01)

(58) **Field of Classification Search**

USPC 347/6, 9, 20, 19

See application file for complete search history.

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(57) **ABSTRACT**

A carriage moving device has a motor, and a carriage. The carriage moves in a first direction when the motor rotates forwardly, while the carriage moves in a second direction which is opposite to the first direction when the motor rotates reversely. The carriage moving device further includes a facing object having a plurality of reflection ratios at a plurality of positions in the scanning direction. A first sensor unit has a light emitting unit configured to emit light to the facing object and a light receiving unit configured to receive light reflected by the facing object. A second sensor unit is configured to output a second signal in response to movement of the carriage. The controller notifies an error of the second sensor unit in response to a condition where a changing amount of the first signal in the reversing step exceeds a threshold amount and the controller cannot obtain the second signal.

18 Claims, 7 Drawing Sheets

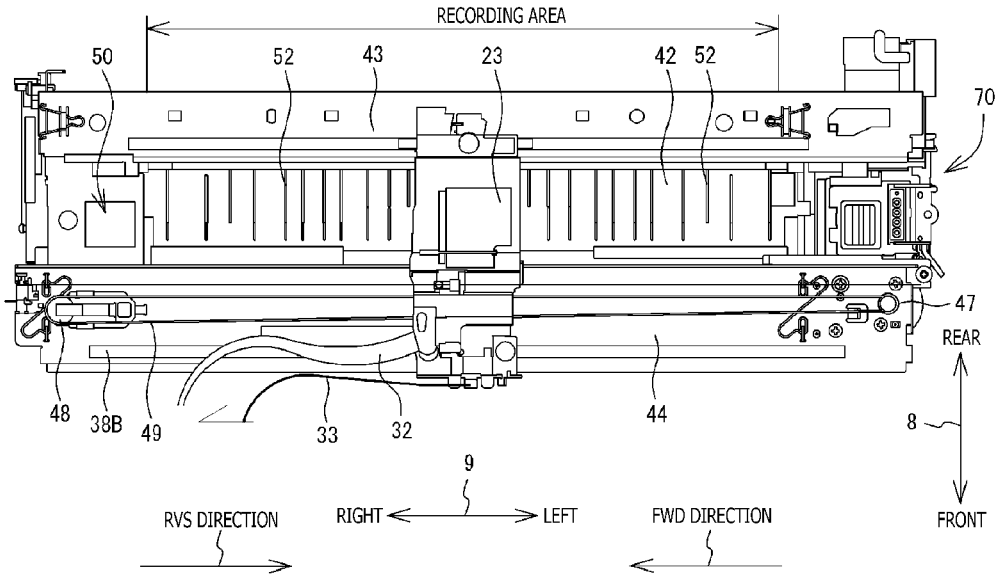
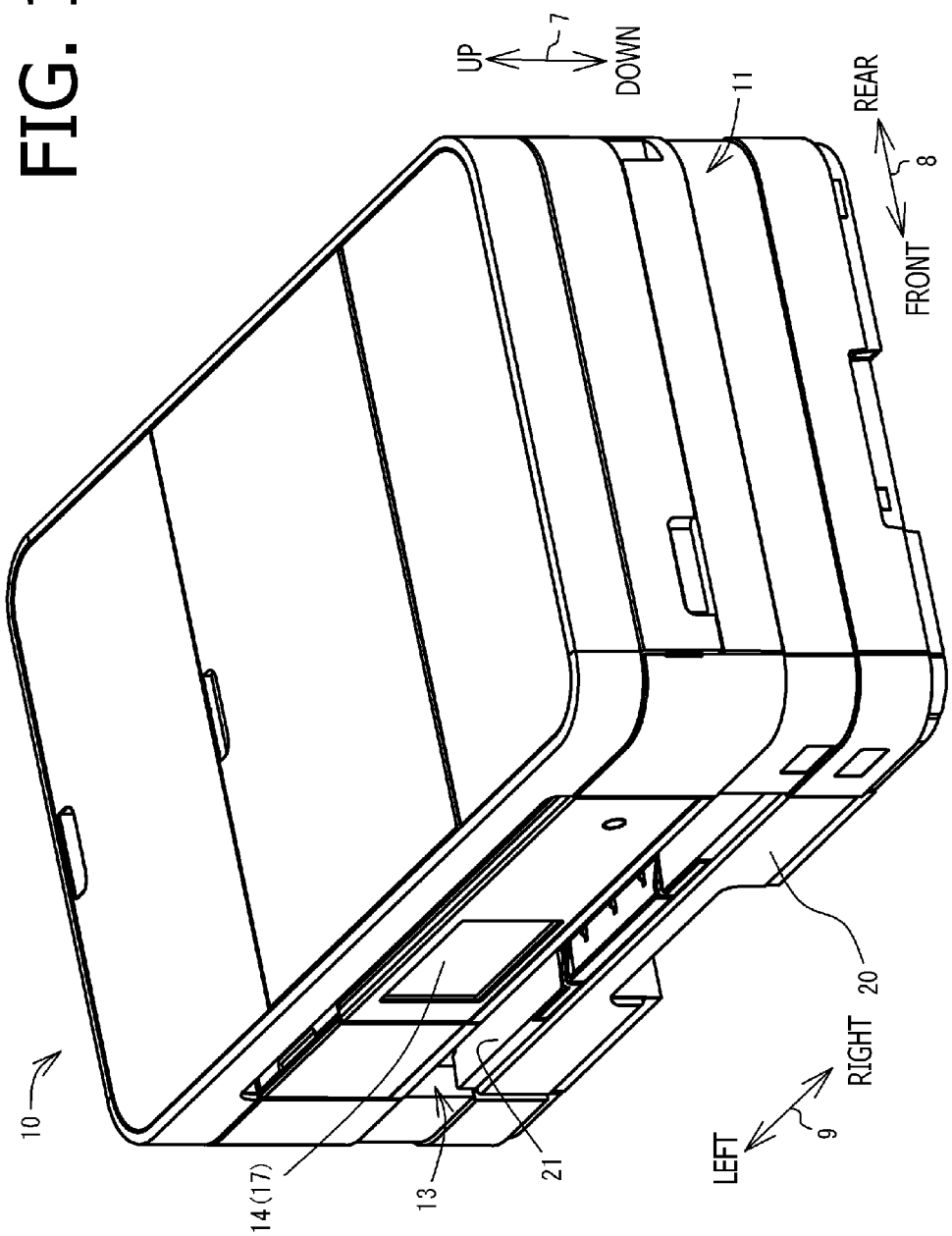


FIG. 1



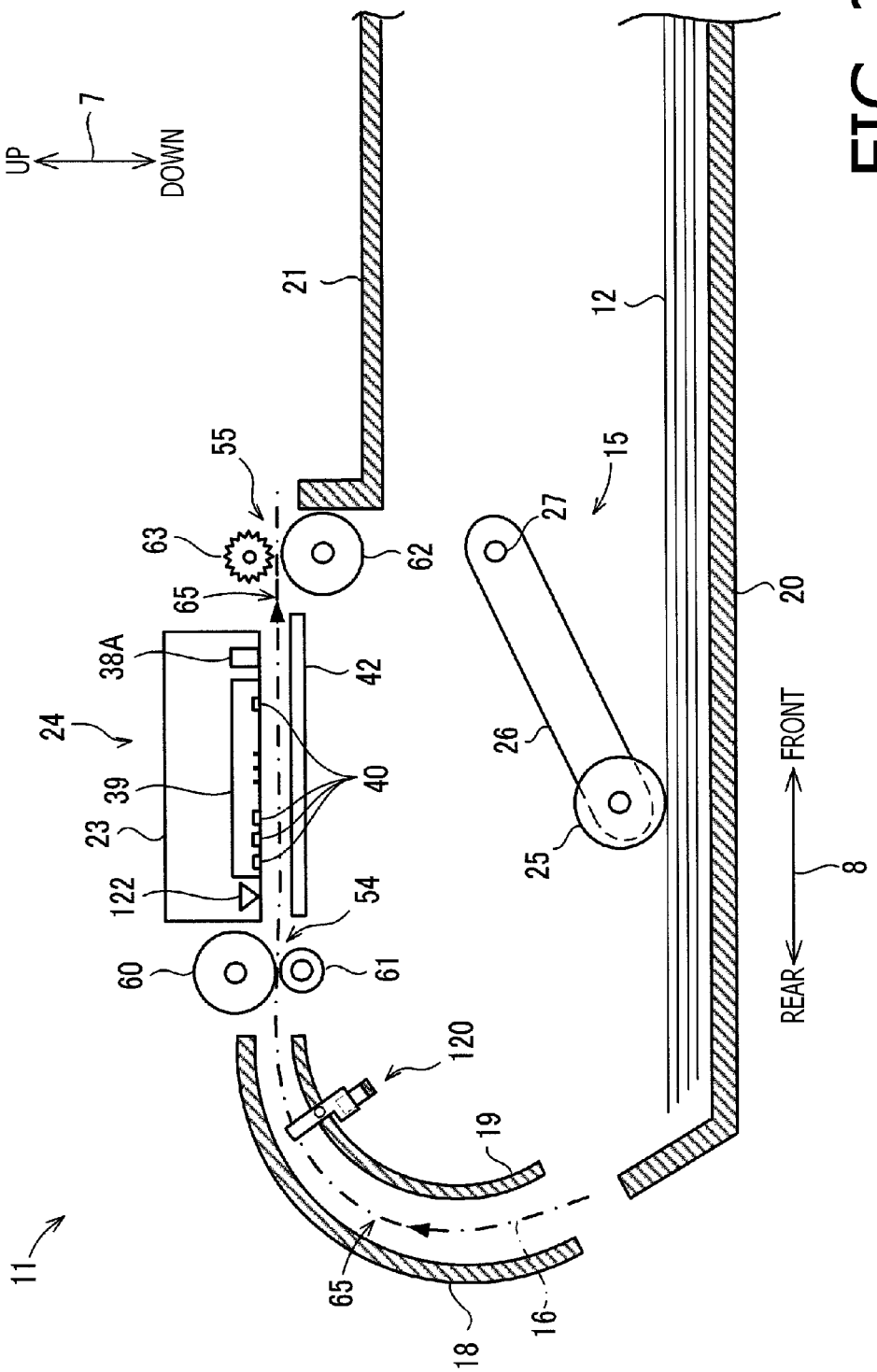

UP
7
DOWN
21
12
55
15
63
27
62
65
20
38A
42
24
26
40
39
FRONT
23
122
54
25
8
60
61
REAR
120
19
11
65
18
16

FIG. 2

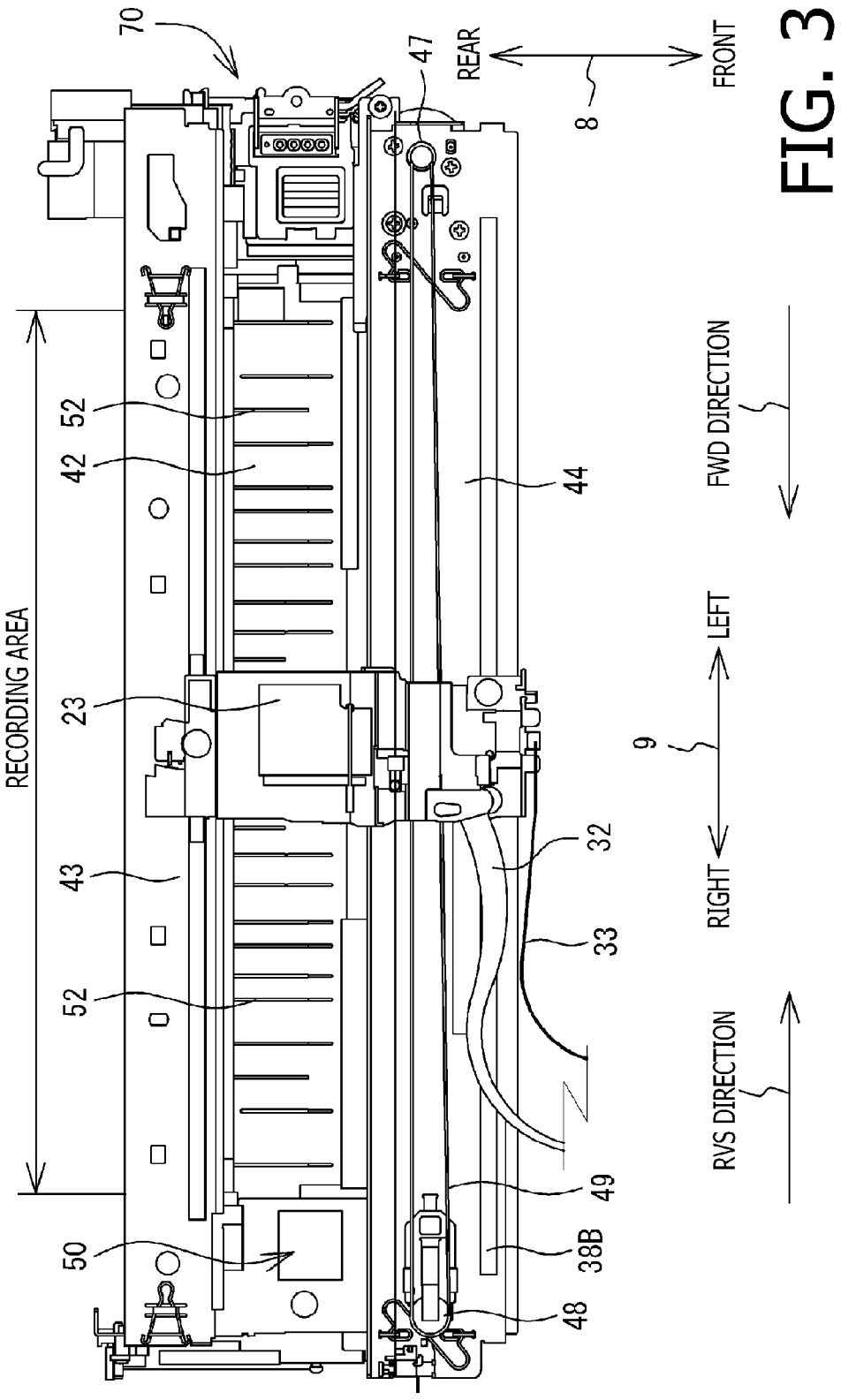

70
47
REAR
FRONT
8
52
42
44
RECORDING AREA
23
43
52
50
32
33
49
38B
48
FWD DIRECTION
LEFT
9
RIGHT
RVS DIRECTION

FIG. 3

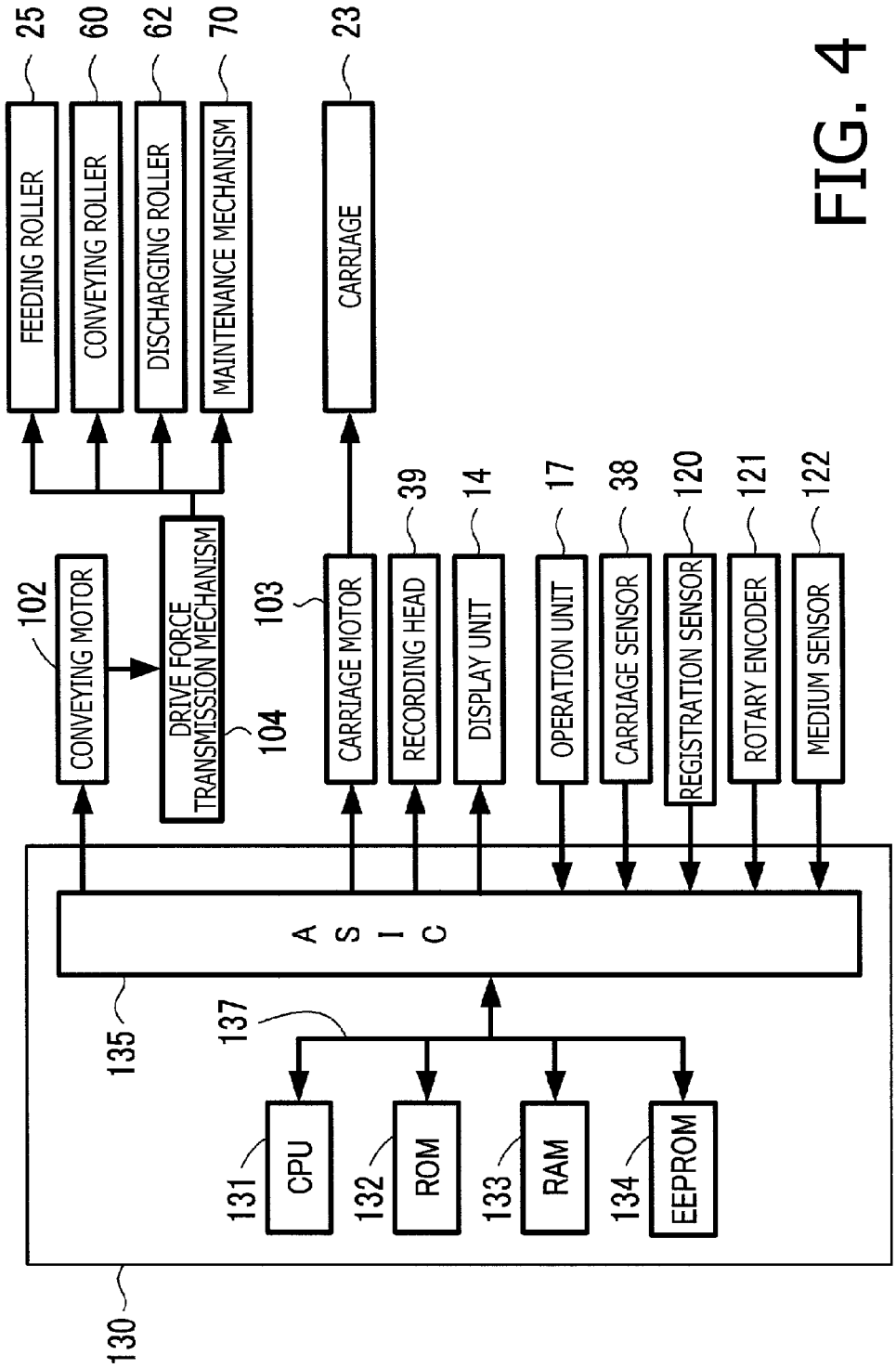
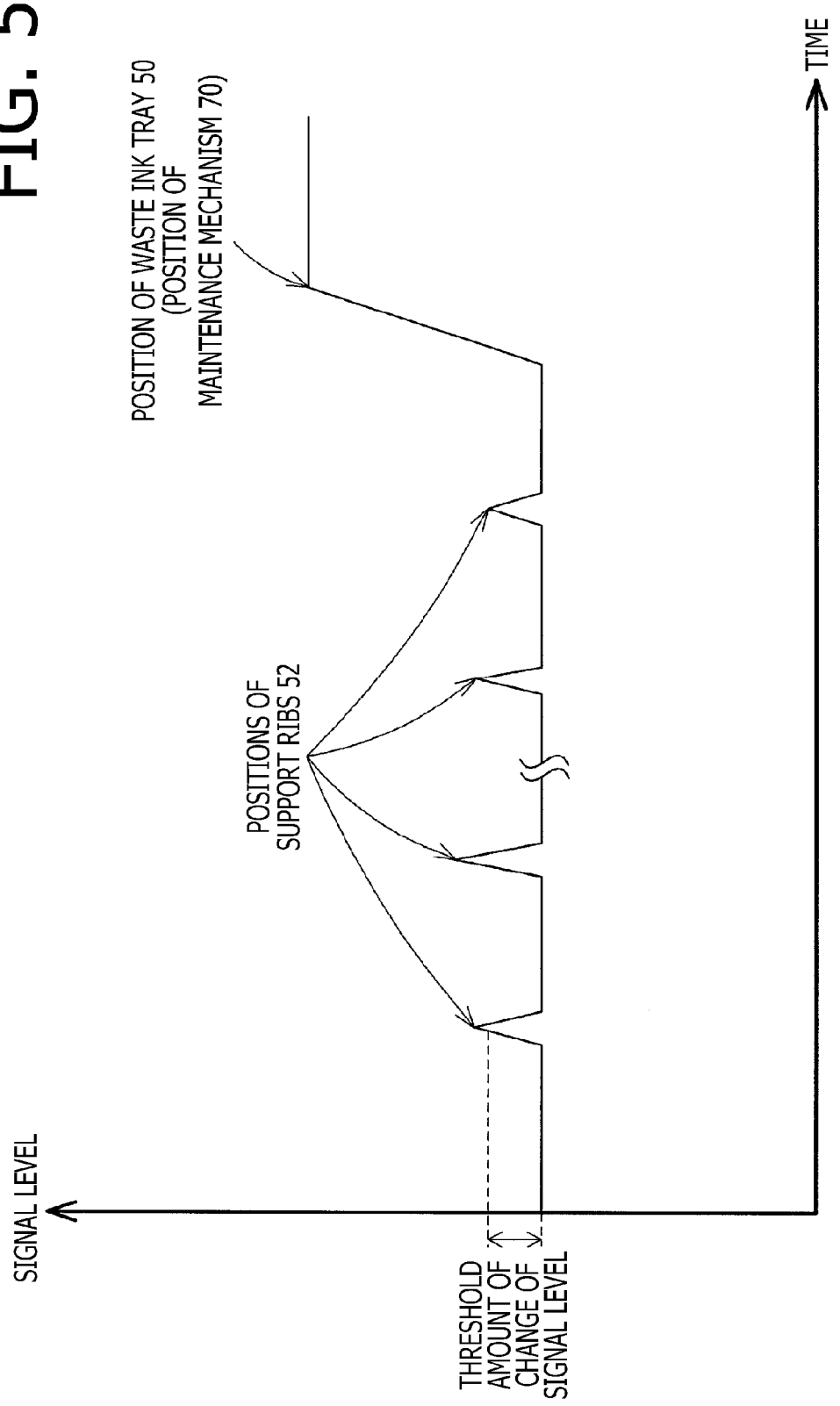

25
60
62
70
23
FEEDING ROLLER
CONVEYING ROLLER
DISCHARGING ROLLER
MAINTENANCE MECHANISM
CARRIAGE
102
CONVEYING MOTOR
DRIVE FORCE TRANSMISSION MECHANISM
104
103
CARRIAGE MOTOR
39
RECORDING HEAD
14
DISPLAY UNIT
17
OPERATION UNIT
38
CARRIAGE SENSOR
120
REGISTRATION SENSOR
121
ROTARY ENCODER
122
MEDIUM SENSOR
A S I C
135
137
131
CPU
132
ROM
133
RAM
134
EEPROM
130

FIG. 4

FIG. 5


POSITION OF WASTE INK TRAY 50
(POSITION OF
MAINTENANCE MECHANISM 70)
POSITIONS OF
SUPPORT RIBS 52
SIGNAL LEVEL
TIME
THRESHOLD
AMOUNT OF
CHANGE OF
SIGNAL LEVEL

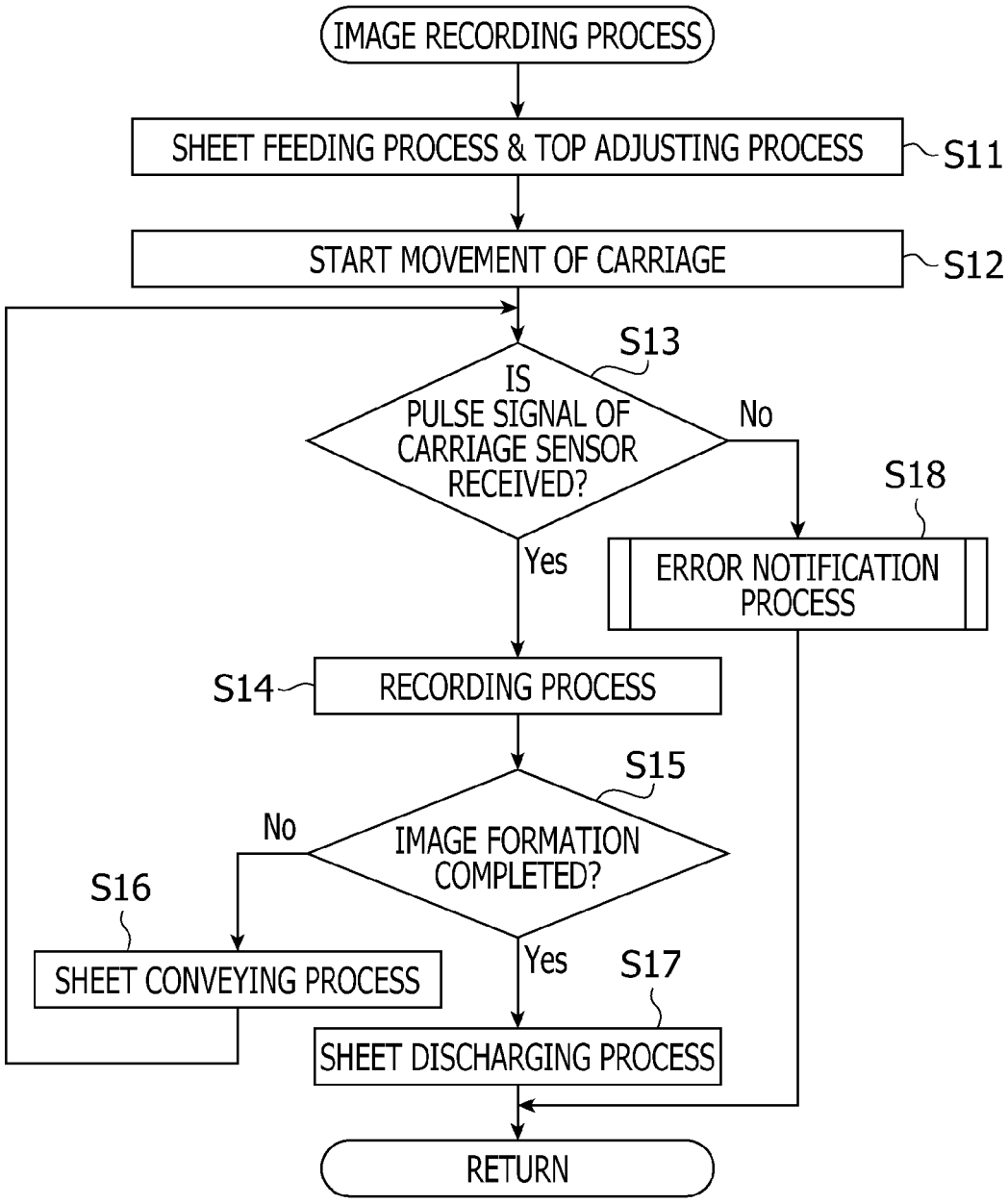
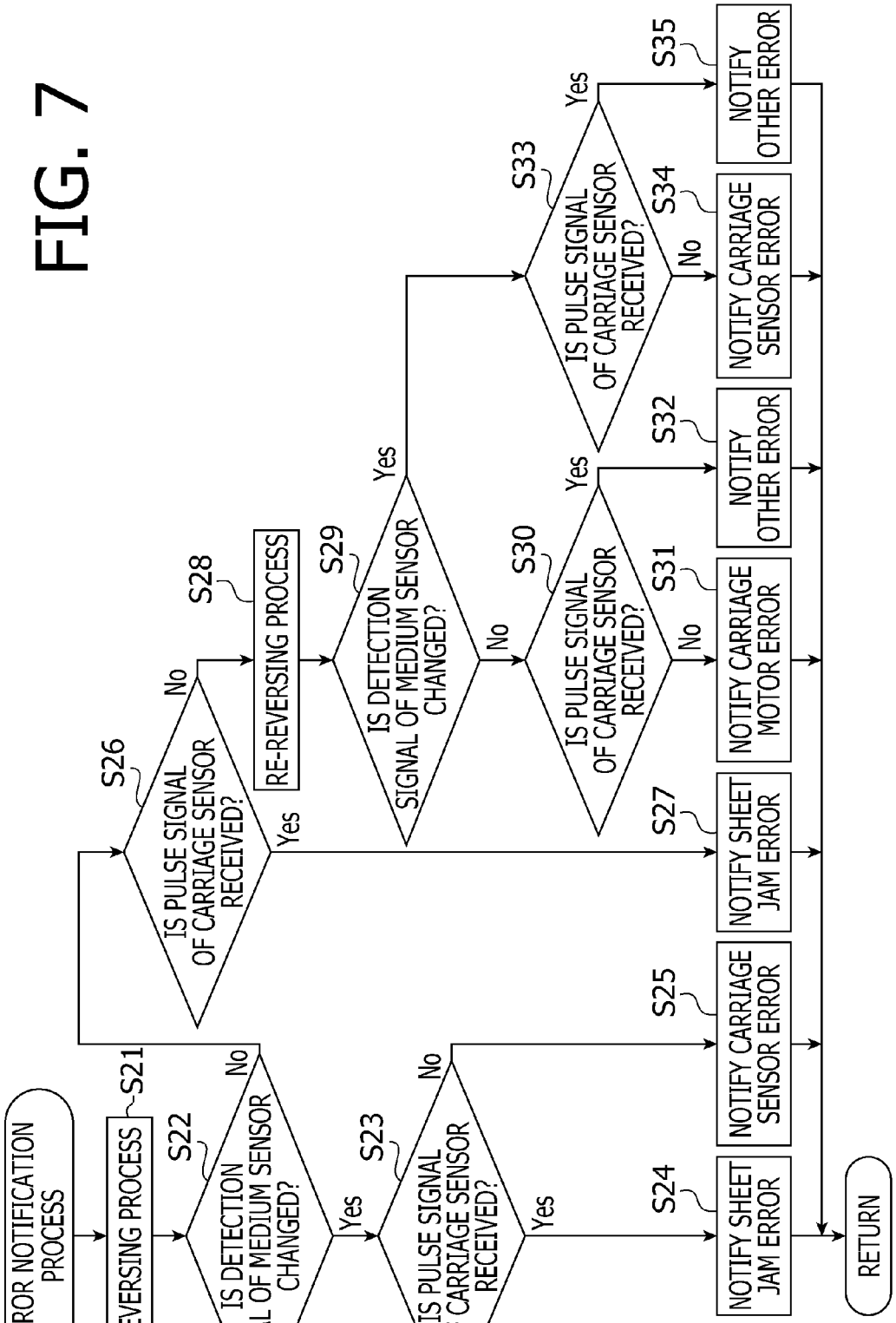


IMAGE RECORDING PROCESS
SHEET FEEDING PROCESS & TOP ADJUSTING PROCESS
S11
START MOVEMENT OF CARRIAGE
S12
S13
IS PULSE SIGNAL OF CARRIAGE SENSOR RECEIVED?
No
Yes
S18
ERROR NOTIFICATION PROCESS
S14
RECORDING PROCESS
S15
IMAGE FORMATION COMPLETED?
No
Yes
S16
SHEET CONVEYING PROCESS
S17
SHEET DISCHARGING PROCESS
RETURN

FIG. 6

FIG. 7


ERROR NOTIFICATION PROCESS
REVERSING PROCESS
S21
S22
IS DETECTION SIGNAL OF MEDIUM SENSOR CHANGED?
No
Yes
S23
IS PULSE SIGNAL OF CARRIAGE SENSOR RECEIVED?
No
Yes
S24
NOTIFY SHEET JAM ERROR
S25
NOTIFY CARRIAGE SENSOR ERROR
S26
IS PULSE SIGNAL OF CARRIAGE SENSOR RECEIVED?
No
Yes
S27
NOTIFY SHEET JAM ERROR
S28
RE-REVERSING PROCESS
S29
IS DETECTION SIGNAL OF MEDIUM SENSOR CHANGED?
No
Yes
S30
IS PULSE SIGNAL OF CARRIAGE SENSOR RECEIVED?
No
Yes
S31
NOTIFY CARRIAGE MOTOR ERROR
S32
NOTIFY OTHER ERROR
S33
IS PULSE SIGNAL OF CARRIAGE SENSOR RECEIVED?
No
Yes
S34
NOTIFY CARRIAGE SENSOR ERROR
S35
NOTIFY OTHER ERROR
RETURN

CARRIAGE MOVING DEVICE, METHOD AND COMPUTER-READABLE RECORDING MEDIUM CONTAINING INSTRUCTIONS TO EXECUTE CARRIAGE MOVING METHOD

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. §119 from Japanese Patent Application No. 2013-205521 filed on Sep. 30, 2013. The entire subject matter of the application is incorporated herein by reference.

BACKGROUND

1. Technical Field

Aspects of the present disclosure relate to a carriage moving device, a carriage moving method and a computer-readable recording medium containing computer-executable instructions to execute the carriage moving method.

2. Conventional Art

Conventionally, an inkjet printer employing a carriage which is movable in a main scanning direction and a recording head mounted on the carriage has been known. Ink is ejected from the recording head while the carriage is moving in the main scanning direction. Typically, the carriage is moved by a motor and rotation of the motor is controlled based on a pulse signal which is output from an encoder unit as the carriage moves. With such a configuration, the carriage can be controlled to locate at a desired position accurately.

SUMMARY

It is generally known that, in a device employing a motor, an operation of the motor is checked when the device is powered ON in order to prevent an error due to runaway of the motor. Typically, in such a device, the carriage is moved in one direction to check the pulse signal of a linear encoder, and then the carriage is moved in an opposite direction to check the pulse signal.

However, according to the operation check described above, when the pulse signal cannot be verified, it is impossible for a user to determine whether the pulse signal cannot be verified due to a disorder of the motor or due to a disorder of the linear encoder.

In consideration of the above, aspects of the disclosure provide an improved carriage moving device or method which is configured to notify appropriate information regarding a cause for an error currently occurring from among a plurality of possible causes.

According to aspects of the disclosure, there is provided a carriage moving device, which has a motor, a carriage movable in a scanning direction, the carriage moving in a first direction along the scanning direction when the motor rotates forwardly, the carriage moving in a second direction which is opposite to the first direction when the motor rotates reversely, a facing object configured to face the carriage, the facing object having a plurality of reflection ratios at a plurality of positions in the scanning direction, a first sensor unit mounted on the carriage at a position where the first sensor unit faces the facing object, the first sensor unit having a light emitting unit configured to emit light to the facing object and a light receiving unit configured to receive light reflected by the facing object, the first sensor unit being configured to output a first signal corresponding to a light amount of the light received by the light receiving unit, a second sensor unit configured to output a second signal in response to movement of the carriage, and a controller. The controller is configured to execute a carriage moving process in which the controller controls the motor to forwardly rotate to move the carriage in the first direction, a reversing process in which the controller controls the motor to reversely rotate to move the carriage in the second direction with controlling the light emitting unit to emit light in response to a condition where a time period during which the second signal cannot be obtained during the carriage movement process, and a notification process in which the controller notifies an error of the second sensor unit in response to a condition where a changing amount of the first signal in the reversing step exceeds a threshold amount and the controller cannot obtain the second signal.

According to further aspects of the disclosure, there is provided a carriage moving method employed in a device having a carriage configured to be movable in a scanning direction, the carriage being moved by a motor. The method includes a carriage moving step of forwardly rotating the motor to move the carriage in a first direction along the scanning direction, a light emitting step of causing a first sensor unit mounted on the carriage to emit light toward a facing object which has different reflection ratios at different positions in the scanning direction when a second signal which is output from a second sensor unit in association with movement of the carriage in the carriage moving step cannot be obtained, a reversing step of reversely rotating the motor to move the carriage in a second direction which is opposite to the first direction in the light emitting step, and a notification step of notifying an error of the second sensor unit when a changing amount of a first signal from the first sensor unit representing a received amount of light emitted by the first sensor unit and reflected by the facing object exceeds a threshold amount and the second signal cannot be obtained.

According to aspects of the disclosure, there is provided a non-transitory computer readable storage device containing instructions which can be executed by a controller of a carriage moving device having a carriage configured to be moved by a motor in a scanning direction. The controller, when executing the instructions, causes the carriage moving device to execute a carriage moving step of forwardly rotating the motor to move the carriage in a first direction along the scanning direction, a light emitting step of causing a first sensor unit mounted on the carriage to emit light toward a facing object which has different reflection ratios at different positions in the scanning direction when a second signal which is output from a second sensor unit in association with movement of the carriage in the carriage moving step cannot be obtained, a reversing step of reversely rotating the motor to move the carriage in a second direction which is opposite to the first direction in the light emitting step, and a notification step of notifying an error of the second sensor unit when a changing amount of a first signal representing a received amount of light emitted by the first sensor unit and reflected by the facing object exceeds a threshold amount and the second signal cannot be obtained.

According to the above configurations, there will be provided an improved carriage moving device or method which is configured to notify appropriate information regarding a cause for an error currently occurring from among a plurality of possible causes.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is a perspective view of an MFP (multi-function peripheral) showing an appearance thereof according to an embodiment of the disclosure.

FIG. **2** is a cross-sectional view schematically showing inner structure of a printer unit of the MFP shown in FIG. **1**.

FIG. **3** is a plan view showing a carriage and guide rails according to embodiment of the disclosure.

FIG. **4** is a block diagram of the printer unit of the MFP shown in FIG. **1**.

FIG. **5** is an exemplary graph showing a chronological variation of a detection signal which is output by a medium sensor during movement of the carriage.

FIG. **6** is a flowchart illustrating an image recording process according to the embodiment of the disclosure.

FIG. **7** is a flowchart illustrating an error notification process according to the embodiment of the disclosure.

DETAILED DESCRIPTION OF EMBODIMENT

Hereinafter, referring to the accompanying drawings, an embodiment of the present disclosure will be described. It is noted that the embodiment described hereinafter is merely an exemplary embodiment, and the embodiment can be modified in various ways without departing from the scope of the present invention.

In the following description directions are described based on arrows indicated in the drawings. Specifically, an up-and-down direction **7** is defined based on a status where the MFP **10** is normally placed for use (i.e., a status shown in FIG. **1**). Further, a side where an opening **13** is formed is referred to as a front side, and an front-and-rear direction **8** is defined. A right-and-left direction **9** is defined based on the right and left directions when the MFP **10** is viewed from the front direction.

The MFP **10** has a printer unit **11**. The printer unit **11** is configured to record (print) images on recording sheets **12** (see FIG. **2**) in accordance with an inkjet recording method.

The printer unit **11** has a sheet feeder **15**, a sheet feed tray **20**, a sheet discharge tray **21**, a sheet conveying roller unit **54**, a recording unit **24**, a sheet discharge roller unit **55** and a platen **42**.

The sheet feed tray **20** is configured to be inserted in and removed from the MFP **10** thorough the opening **13** formed on a front surface of the printer unit **11** (see FIG. **1**) along the front-and-rear direction **8**. The sheet feed tray **20** is capable of accommodating a plurality of recording sheets **12**. The sheet discharge tray **21** is arranged above sheet feed tray **20**. The sheet discharge tray **21** receives and supports the recording sheets **12** discharged by the discharge roller unit **55**.

The sheet feeder **15** has a feeding roller **25**, a sheet feed arm **26** and a shaft **27** as shown in FIG. **2**. The feeding roller **25** is rotatably supported at a distal end of the sheet feed arm **26**. The feeding roller **25** rotates in a forward-rotation direction in which the recording sheet **12** on the sheet feed tray **20** is conveyed in a sheet conveyed direction **16** toward a sheet path **65** when a conveying motor **102** (see FIG. **4**) reversely rotates. The sheet feed arm **26** is rotatably supported by the shaft **27** which is supported by a frame of the printer unit **11**. The sheet feed arm **26** is rotatably urged toward the sheet feed tray **20** by an elastic force caused by its own weight and/or an urging member such as a spring.

The sheet path **65** is configured such that a part thereof is defined by an outer guide member **18** and an inner guide member **19** The sheet path **65** is a path extending from a rear end part of the sheet feed tray **20** to a position on a rear side of the sheet discharge tray **21**. The path **65** extends from a lower rear position of the printer unit **11** to an upper position with making a U-turned path, then passes through the recording unit **24** and reaches the sheet discharge tray **21**. In FIG. **2**, a conveyed direction **16** of the recording sheet **12** in the sheet path **65** is indicated by a dotted line and arrow.

The conveying roller unit **54** is arranged on an upstream, in the sheet conveyed direction **16**, with respect to the recording unit **24** (see FIG. **2**). The conveying roller unit **54** has a conveying roller **60** and a pinch roller **61** which face each other. The conveying roller **60** is driven to rotate by the conveying motor **102**. The recording sheet **12** is nipped between the conveying roller **60**, which rotates in a forward direction as the conveying motor **102** forwardly rotates, and the pinch roller **61**, and conveyed in the conveyed direction **16**.

The discharge roller unit **55** is arranged at a downstream with respect to the recording unit **24** (see FIG. **2**). The discharge roller unit **55** has a discharge roller **62** and a spur roller **63** which face each other. The discharge roller **62** is driven by the conveying motor **102** to rotate. The recording sheet **12** is nipped between the discharge roller **62**, which rotates in a forward direction as the conveying motor **102** forwardly rotates, and the spur roller **63**, and conveyed in the conveyed direction **16**.

The printer unit **11** has a registration sensor **120** at an upstream, in the conveyed direction **16**, with respect to the conveying roller unit **54**. The registration sensor **120** is for detecting whether a recording sheet **12** is present/absent at a position where the registration sensor **120** is arranged. When a recording sheet **12** is located at the position where the registration sensor **120** is arranged, the registration sensor **120** transmits a detection signal of a low-level signal to a controller **130**. When no recording sheet **12** is located at the position, the registration sensor **120** transmits a detection signal of a high-level signal to the controller **130**.

The printer unit **11** has a well-known rotary encoder **121** which generates a pulse signal in accordance with rotation of the conveying roller **60** (in other words, a rotation of the conveying motor **102**) as shown in FIG. **4**. The rotary encoder **121** is of a well-known structure and has an encoder disk and an optical sensor. The encoder disk of the rotary encoder **121** rotates in association with a rotation of the conveying roller **60**. The optical sensor of the rotary encoder **121** reads a pattern formed on the rotating encoder disk to generate a pulse signal, and transmits the thus generated pulse signal to the controller **130**.

The recoding unit **24** is arranged to face the platen **42** in the up-and-down direction **7**. The recording unit **24** has a carriage **23**, a recording head **39**, an encoder sensor **38**A and a medium sensor **122**. From the carriage **23**, an ink tube **32** and a flexible flat cable **33** are extended as shown in FIG. **3**. The ink tube **32** is for supplying ink of the ink cartridge to the recording head **39**. The flexible flat cable **33** connects a controller substrate implemented with the controller **130** with the recording head **39**.

The carriage **23** is supported by guide rails **43** and **44** (see FIG. **3**). The carriage **23** is connected to a well-known belt drive mechanism provided to the guide rail **44**. The belt drive mechanism includes a driving pulley **47** provided to at one end, in the right-and-left direction **9**, of the guide rail **44**, a driven pulley **48** provided to the other end of the guide rail **44**, and an endless belt **49** wound around the driving pulley **47** and the driven pulley **48**.

The carriage **23** is connected to the belt **49**. As the driving pulley **47**, which is rotated by the driving force of a carriage motor **103** (see FIG. **4**), moves the belt **49** to rotate, the carriage **23** makes a reciprocating movement in the right-and-left direction **9** (i.e., the scanning direction). Specifically, when the carriage motor **103** makes a forward rotation, the carriage **23** moves from right to left (i.e., FWD direction) in

the right-and-left direction **9**. When the carriage motor **103** makes a reverse rotation, the carriage **23** moves from left to right (i.e., RVS direction) in the right-and-left direction **9**.

The recording head **39** is mounted on the carriage **23** (see FIG. **2**). On a bottom surface of the recording head **39**, a plurality of nozzles **40** are formed. The recording head **39** is configured such that the nozzles **40** eject small ink drops. Specifically, the recording head **39** ejects small ink drops through the plurality of nozzles **40** on to the recoding sheet **12** supported by the platen **42** while the carriage **23** is moving in the scanning direction, thereby an image is recorded on the recording sheet **12**.

On the guide rail **44**, an encoder strip **38**B is provided. The encoder sensor **38**A is mounted on the carriage **23**. While the carriage **23** is moving, the encoder sensor **38**A reads the encoder strip **38**B and generates a pulse signal, and transmits the generated pulse signal to the controller **130**. The encoder sensor **38**A and the encoder strip **38**B constitute a carriage sensor **38** (see FIG. **4**).

The platen **42** is arranged between, in the sheet conveyed direction **16**, the conveying roller unit **54** and the discharge roller unit **55** (see FIG. **2**). The platen **42** is configured to support the recording sheet **12** conveyed by the sheet conveying roller unit **54** from the below. On the upper side of the platen **42**, a plurality of supporting ribs **52** which protrude upward and extend along the front-and-rear direction **8** are formed (see FIG. **3**). The plurality of ribs **52** are arranged in the right-and-left direction **9** at certain intervals.

Portions at which the supporting ribs **52** are formed and portions at which the supporting ribs **52** are not formed have different reflection ratios. That is, the platen **42** is formed such that portions having different reflection ratios are arranged alternately in the right-and-left direction **9**. It is noted that the cause for the different reflection ratios is not limited to a particular structure. For example, the different reflection ratios may be realized since the height of the portions where the supporting ribs **52** are formed and the height of the portions at which the supporting ribs are not formed are different (i.e., distances to the medium sensor **122** are different). Alternatively, the color of the portions where the plurality of ribs are formed and the color of the portions where the plurality of ribs are not formed may have different colors.

The MFP **10** has a maintenance mechanism **70** as shown in FIG. **3**. The maintenance mechanism **70** is arranged outside and on the right side of a recording range within which the carriage **23** reciprocates during image formation. It is noted that, within the recording range, the recording head **39** can face the recording sheet **12** placed on the platen **42**. The maintenance mechanism **70** performs a purge process for removing ink, air bubbles and other foreign particles from the nozzles **40** of the recording head **39** with suctioning when the carriage **23** is located on the right side with respect to the recording range. It is noted that reflection ratio of the upper surface of the maintenance mechanism **70** is largely different from reflection ratio of the upper surface of the platen **42**.

The MFP **10** has a waste ink tray **50** which is arranged in an area outside and on the left side of the recording range. In an inner space of the waste ink tray **50**, an ink absorbing member is accommodated. Further, the waste ink tray **50** has an opening on an upper surface thereof facing the lower surface of the recording head **39**, and is capable of receiving the ink discharged from the recording head **39** through the opening. The reflection ratio of the upper surface of the waste ink tray **50** is largely different from the reflection ratio of the upper surface of the platen **42**. For example, on the upper surface of the waste ink tray **50**, the ink absorbing member is exposed to outside through the opening. The ink absorbing member typically has a white color, and the platen **42** typically has a color (e.g., black) which has a lower reflection ratio than the white member.

The medium sensor **122** is mounted on a bottom surface (i.e., a surface facing the platen **42**) of the carriage **23** as shown in FIG. **2**. The medium sensor **122** has a light emitting unit having an LED (light emitting diode) and a light receiving unit having an optical sensor. The light emitting unit is configured to emit light, of which light amount is specified by the controller **130**, to the platen **42**, to the maintenance mechanism **70** or to the waste ink tray **50**. The light emitted to the platen **42** is reflected by the platen **42**, the maintenance mechanism **70** or the waste ink tray **50**. The reflected light is received by the light receiving unit.

The medium sensor **122** transmits a detection signal corresponding to the amount of the light received by the light receiving unit to the controller **130**. For example, the medium sensor **122** transmits a higher level detection signal when the light amount of the received light is greater. It is noted that, the light emitted by the light emitting unit during the movement of the carriage **23** will be reflected by the supporting ribs **52**, positions of the platen **42** other than the portions of the ribs **52**, the maintenance mechanism **70**, and the waste ink tray **50** which have different reflection ratios. The light reflected by the above portions is received by the light receiving unit. That is, the level of the signal of the detection signal output by the medium sensor **122** varies during the movement of the carriage **23** in the scanning direction.

A driving force transmission mechanism **104** (see FIG. **4**) is configured to transmits the driving force of the conveying motor **102** to the feeding roller **25**, the conveying roller **60**, the discharging roller **62** and the maintenance mechanism **70**. The driving force transmission mechanism **104** may include all or part of gears, pulleys, an endless belt, a planetary gear mechanism (a pendulum gear mechanism) and a one way clutch mechanism.

A display unit **14** includes a display screen on which information to be notified to a user is displayed as messages and/or animations. The display unit **14** may have any type of well-known structure. For example, the display unit **14** may have an LCD (liquid crystal display), an organic EL (electro-luminescence) display and the like.

An operation unit **17** is an input interface used to acquire user input of operation instructions for the MFP **10**. The operation unit **17** may have any type of well-known structure. For example, as shown in FIG. **1**, the operation unit **17** may have a plurality of depression buttons. Alternatively or optionally, the operation unit **17** may have a touch panel overlaid on the display screen of the display unit **14**.

The controller **130** has a CPU (central processing unit) **131**, a ROM **132**, a RAM **133**, an EEPROM **134** and an ASIC **135**, which are interconnected through an inner bus **137**. The ROM **132** stores programs necessary for the CPU **131** to control various operations of the MFP **10**. The RAM **133** is used as a storage area for temporarily storing data and signals when the CPU **131** executes various programs and/or a work area to be used for data processing. The EEPROM **134** stores settings and flags which are to be retained after the MFP **10** is powered OFF.

The ASIC **135** is connected to the conveying motor **102** and the carriage motor **103**. The ASIC **135** obtains drive signals to rotate each of the conveying motor **102** and the carriage motor **103** from the CPU **131**, and supplies driving currents corresponding to the obtained drive signals. Each of the conveying motor **102** and the carriage motor **103** rotates forwardly/reversely depending on the drive current supplied from the ASIC **135**. The controller **130** may control driving of the

conveying motor **102** to drive each of the feeding roller **25**, conveying roller **60**, and discharging roller **62**. The controller **130** may control the drive of the carriage motor **103** to reciprocally move the carriage **23**. Further, the controller **130** controls the recording head **39** to eject the ink through the nozzles **40**.

Further, to the ASIC **135**, the carriage sensor **38**, the registration sensor **120**, the rotary encoder **121** and the medium sensor **122** are connected. The controller **130** detects the location of the carriage **23** based on the pulse signal output by the carriage sensor **38**. The controller **130** detects the location of the recording sheet **12** based on the detection signal output by the registration sensor **120** and the pulse signal output by the rotary encoder **121**. Further, the controller **130** detects movement of the carriage **23** based on the detection signal output by the medium sensor **122**.

Specifically, the controller **130** repeatedly obtains the detection signal output by the medium sensor **122** during the movement of the carriage **23** at every constant sampling period. FIG. **5** shows chronological change of the detection signal output by the medium sensor **122** and obtained by the controller **130** when the carriage **23** shown in FIG. **3** is moved in FWD direction (or RVS direction). As shown in FIG. **5**, the detection signal output by the medium sensor **122** and obtained by the controller **130** varies in association with the moving time (which corresponds to a location) of the carriage **23**.

In the example shown in FIG. **5**, the level of the detection signal output by the medium sensor **122** when facing the supporting ribs **52** of the platen **42** is higher than that when the medium sensor **122** faces a portion on the platen **42** other than the ribs **52**. Further, as shown in FIG. **5**, the levels of the detection signals at positions corresponding to different ribs **52** may not be the same, but may vary. Further, the level of the detection signal output by the medium sensor **122** when facing the waste ink tray **50** (or the maintenance mechanism **70**) is much higher than the detection signal of the medium sensor **122** when facing the platen **42**. It is noted that the levels of the signals shown in FIG. **5** are only examples according to the embodiment, and aspects of the disclosure need not be limited to the depicted levels and/or relationship. For example, in another embodiment, the level of the detection signal corresponding to a portion on the platen **42** other than the supporting ribs **52** may be the highest, while the level of the detection signal corresponding to the waste ink tray **50** or the maintenance mechanism **70** may be the lowest.

According to the embodiment, the controller **130** detects that the carriage **23** is moving when the changing amount of the detection signals output by the medium sensor **122** and obtained by the controller **130** within a constant period (typically, continuously) exceeds a threshold amount of change of the signal levels. When the carriage **23** is not moving, the changing amount of the detection signal output by the medium sensor **122** is equal to or less than the threshold amount of change of the signal levels. It is noted that, the threshold amount may be set to an average changing amount of the signal level of the detection signal corresponding to the platen **42** at which the difference of the reflection ratios (i.e., difference between the reflection ratio at the supporting ribs **52** and the reflection ratio at a portion where the rib **52** is not provided) is the smallest.

FIG. **6** shows an image recording process executed by the CPU **131** of the controller **130**. Processes described hereinafter may be executed such that the CPU **131** retrieves programs stored in the ROM **132** and/or hardware circuits implemented in the controller **130** may realize the processes. It is noted that the image recording process is described mainly referring to rotations of the feeding roller **25**, the conveying roller **60** and the discharging roller **62** and/or movement of the carriage **23**. These operations are realized by driving the conveying motor **102** and the carriage motor **103**.

When the controller **130** obtains an instruction to start recording operation, the controller **130** executes the image recoding process shown in FIG. **6**. The instruction to start image recording may be obtained from anywhere. For example, the controller **130** obtains the instruction through the operation unit **17** provided to the MFP **10**. Alternatively or optionally, the controller **130** may obtains the instruction from an external device through a communication network. The controller **130** controls operations of each roller, the carriage **23** and the recording head **39** based on the obtained instructions to execute image recording on the recording sheet **12**.

The controller **130** executes a sheet feeding process and a top adjusting process (S**11**). The sheet feeding process is to feed the recoding sheet **12** accommodated in the sheet tray **20** to the sheet path **65**, and cause the leading end of the recording sheet **12** to reach the conveying roller unit **54**. The top adjusting process is a process to convey the recording sheet **12** of which the leading end has reached the conveying roller unit **54** to a position at which an area of the recording sheet **12** on which an image is initially recorded faces the recording head **39**.

The controller **130** controls the conveying motor **102** to reversely rotate so that the feeding roller **25** is forwardly rotated in the sheet feeding process. The controller **130** keeps the conveying motor **102** reversely rotating until the leading end of the recording sheet **12** located at the position where the registration sensor **120** is arranged reaches the conveying roller unit **54**. It is noted that the position of the leading end of the recording sheet **12** is identified based on a combination of change of the signal output by the registration sensor **120** and the pulse signal output by the rotary encoder **121**. Further, in the top adjusting process, the controller **130** controls the conveying motor **102** to forwardly rotate so that the conveying roller **60** and the discharging roller **62** forwardly rotate.

Next, the controller **130** starts moving the carriage **23** (S**12**). Specifically, the controller **130** supplies a driving current for moving the carriage **23** in the predetermined direction to the carriage motor **103**. This step is a part of the recording process executed in S**14**. It is noted that the direction in which the carriage **23** is to be moved differs depending on the location of the carriage **23** when S**12** is executed. The controller **130** stores the location of the carriage **23** and moving direction of the carriage **23** when S**12** is executed in the RAM **133** or the like. According to the embodiment, the following description is made assuming that the carriage **23** is moved in the FWD direction when S**12** is executed.

When the controller **130** obtains the pulse signal from the carriage sensor **38** (S**13**: YES), the controller **130** executes the recording process (S**14**). In the recording process, the controller **130** starts moving the carriage **23** in the FWD direction (the direction being determined based on the location of the carriage **23** when S**12** is executed), and causes the recording head **39** to eject ink drops from the nozzles **40** when the carriage **23** is moving. With this control, in the area of the recording sheet **12** facing the recording head **39** with the top adjusting process, an image is recorded. It is noted that the location of the carriage **23** is identified based on the pulse signal output by the carriage sensor **38**.

If an image has not been recorded on the recording sheet **12** (S**15**: NO), the controller **130** executes a conveying process (S**16**). The conveying process is a process to convey the recording sheet **12** by a predetermined amount (i.e., a line

feed width) in the conveyed direction **16**. Specifically, the controller **130** controls the conveying motor **102** to forwardly rotate so that the conveying roller unit **54** and the discharging roller unit **55** convey the recording sheet **12** by the predetermined line feed width in the conveyed direction **16**.

The controller **130** repeatedly executes steps S**12**-S**16** until image recording on the recording sheet **12** is judged to be finished (S**15**: YES). Optionally, in the recording process (S**14**), the controller **130** may control movement of the carriage **23** in the RVS direction and control the recording head **39** to eject ink drops from the nozzles during the movement of the carriage **23** in the RVS direction. When recording of the image on the recording sheet **12** is completed (S**15**: YES), the controller **130** executes the discharging process (S**17**) for discharging the recording sheet **12** on which the image has been recorded onto the discharge tray **21** (S**17**). Specifically, the controller **130** controls the conveying motor **102** to forwardly rotate until the recording sheet **12** is discharged on the discharge tray **21**. Thereafter, the controller **130** finishes the image recording process.

If the controller **130** cannot obtain the pulse signal from the carriage sensor **38** (S**13**: NO), the controller **130** executes an error notification process (S**18**), and finishes the image recording process. There could be a plurality of error conditions in which the controller **130** cannot obtain the pulse signal from the carriage sensor **38**. In the error notification process, the controller **130** identifies the error currently occurring from among the plurality of error conditions, and notifies the identified error condition to the user.

It is noted that, according to the embodiment, if the carriage sensor **38** operates normally, the pulse signal is output from the carriage sensor **38** within 50 msec after the carriage motor **103** is activated. Therefore, the controller **130** waits, by at least 50 msec, for output of the pulse signal from the carriage sensor **38**. It is noted that the time period 50 msec is an exemplary threshold period, and according to another embodiment, different time period may be employed.

Hereinafter, with reference to FIG. **7**, the error notification process will be described in detail. Firstly, the controller **130** executes a reversing process (S**21**). The reversing process is a process to supply electrical current for moving the carriage **23** in a direction opposite to the moving direction as S**12** to the carriage motor **103**. According to the embodiment, the controller **130** supplies electrical current for reversely rotating the carriage motor **103** (i.e., for moving the carriage **23** in the RVS direction) to the carriage motor **103**. In the following description, the electrical current for reversely rotating the carriage motor **103** will be referred to as a first current. Further, the controller **130** controls the light emission unit of the medium sensor **122** to emit light. Thus, in the reversing process, the carriage **23** moves in the RVS direction with light emission from the medium sensor **122**.

Next, in the reversing process (S**21**), if the changing amount of the detection signal output by the medium sensor **122** exceeds a threshold amount (S**22**: YES), and if the controller **130** can obtain the pulse signal from the carriage sensor **38** (S**23**: YES), the controller **130** notifies that there exists a foreign agent (typically, the jammed recording sheet **12**) in the moving path of the carriage **23** (S**24**). It is noted that an error notified at S**24** is determined based on a combination of the signals output from the medium sensor **122** and the carriage sensor **38**. In S**25**, S**27**, S**31**, S**32**, S**34** and S**35**, errors are determined and notified in a similar manner.

For example, when the movement of the carriage **23** in the FWD direction is prevented due to the foreign agent existing in the moving path thereof, while the movement in the RVS direction is allowed, S**24** is executed. Concrete methods of notifying errors are not limited to any specific methods. For example, text messages or animations may be displayed on the display unit **14**. Audio messages may be output with a speaker (not shown). Alternatively or optionally, notification may be made using a display unit or the like of an external device which is connected to the MFP **10** via a communication network.

If the changed amount of the detection signal output by the medium sensor **122** exceeds a threshold amount (S**22**: YES) and the controller **130** cannot obtain the pulse signal from the carriage sensor **38** (S**23**: NO), the controller **130** notifies an error of the carriage sensor **38** to the user (S**25**). Step S**25** is executed, for example, when the carriage motor **103** operates normally but the carriage sensor **38** is unable to output the pulse signal. Specifically, such a condition may occur when the encoder sensor **38**A does not operate normally, or the encoder strip **38**B is dirtied by the ink or the like.

If the changing amount of the detection signal output by the medium sensor **122** is equal to or less than the threshold amount (S**22**: NO) and if the controller **130** can obtain the pulse signal from the carriage sensor **38** (S**26**: YES), the controller **130** notifies that a foreign agent (typically, the jammed recording sheet **12**) may exist in the moving path of the carriage **23** (S**27**). S**27** is similar to S**24**.

It is noted that a case where the changing amount of the detection signal output by the medium sensor **122** is equal to or less than the threshold amount when the carriage **23** moves in the RVS direction may be a case where the upper surface of the platen **42** is covered with the recording sheet **12**. Alternatively, there could be a case where an error occurs on the medium sensor **122**. Therefore, in S**27**, the controller **130** may further notify a possibility of an error of the medium sensor **122**.

If the changing amount of the detection signal output by the medium sensor **122** is equal to or less than the threshold amount (S**22**: NO) and the controller **130** cannot obtain the pulse signal from the carriage sensor **38** (S**26**: NO), the controller **130** executes re-reversing process (S**28**).

Re-reversing process is a process to supply electrical current for moving the carriage **23** in a direction opposite to the moving direction on the reversing process (S**21**) to the carriage motor **103**. According to the embodiment, the controller **130** supplies the electrical current (hereinafter, referred to as a second current) for controlling the carriage motor **103** to rotate forwardly (i.e., for moving the carriage **23** in the FWD direction) to the carriage motor **103**. Further, the controller **130** causes the light emitting unit of the medium sensor **122** to emit light. That is, in the re-reversing process, the carriage **23** moves in the FWD direction with the medium sensor **122** emitting light.

If the changing amount of the detection signal output by the medium sensor **122** is equal to or less than a threshold amount (S**29**: NO) and the controller **130** cannot obtain the pulse signal from the carriage sensor **38** (S**30**: NO), the controller **130** notifies an error of the carriage motor **103** to the user (S**31**).

It is noted that S**31** is executed when the movement of the carriage **23** cannot be detected even if the first current or second current is supplied to the carriage motor **103**. Since each of the detection signals respectively output by the medium sensor **122** and the carriage sensor **38** indicates that the carriage **23** does not move, changes are low that an error is occurring in the sensors. Further, since the carriage **23** cannot move in the FWD direction or the RVS direction, the error is not due to the jammed recording sheet **12** but an error of the carriage motor **103**.

If the changing amount of the detection signal output by the medium sensor **122** is equal to or less than the threshold amount (S**29**: NO) and the controller **130** can obtain the pulse signal from the carriage sensor **38** (S**30**: YES), the controller **130** notifies the user of errors due to other causes (S**32**). A case where S**32** is executed may be a case where the pulse signal cannot be obtained when the carriage **23** is moved in the FWD direction in S**12**, but the pulse signal can be obtained from the carriage sensor **38** when the carriage **23** is moved in the FWD direction in S**28** (i.e., S**30**: YES).

The above condition may occur, for example, when the movement of the carriage **23** is prevented due to unknown reason when S**12** or S**21** is executed, and the error is resolved when S**28** is executed. If S**32** is further executed, there is a possibility that an error occurs in the medium sensor **122**. Therefore, the controller **130** may notify the user of occurrence of unknown error in S**32**, and further notifies the user of restarting of the MFP **10**.

If the changing amount of the detection signal output by the medium sensor **122** exceeds the threshold amount (S**29**: YES) and the controller **130** cannot obtain the pulse signal from the carriage sensor **38** (S**33**: NO), the controller **130** notifies the user of an error condition of the carriage sensor **38** (S**34**). It is noted that S**25** is similar to S**34**. A case where S**34** is executed is a case, for example, the error notification process is executed with the carriage **23** facing the maintenance mechanism **70**, the carriage **23** cannot move in the RVS direction any more in the reversing process (S**21**), and the carriage **23** can move in the FWD direction in the re-reversing process (S**28**).

If the changing amount of the detection signal output by the medium sensor **122** exceeds the threshold amount (S**29**: YES) and the controller **130** can obtain the pulse signal from the carriage sensor **38** (S**33**: YES), the controller **130** notifies the user of errors due to other causes (S**35**). It is noted that the process in S**32** is substantially equal to S**35**.

According to the embodiment, depending on a combination of the signals respectively output by the carriage sensor **38** and the medium sensor **122**, appropriate information regarding which of the carriage sensor **38** and the carriage motor **103** contains an error condition can be notified to the user. Therefore, even if an error occurs, quick restoration of the MFP **10** can be expected.

In the error notification process shown in FIG. **7**, process is diverged in accordance with all possible combinations of the signals output by the carriage sensor **38** and the medium sensor **122** (i.e., S**22**, S**23**, S**26**, S**29**, S**30** and S**33**). The invention should not be limited to such a configuration. For example, S**26** and S**27** may be omitted. That is, the controller **130** may be configured to execute the re-reversing process (S**28**) if the changing amount of the detection signal output by the medium sensor **122** is equal to or less than the threshold amount (S**22**: NO).

For another example, steps S**30** and S**32** may be omitted. That is, the controller **130** may be configured to notify the user of the error of the carriage motor **103** (S**31**) if the changing amount of the detection signal output by the medium sensor **122** is equal to or less than the threshold amount (S**29**: NO). For another example, steps S**33** and S**35** may be omitted. That is, the controller **130** may notify the user of an error of the carriage sensor **38** (S**34**) if the changing amount of the detection signal output by the medium sensor **122** exceeds the threshold amount (S**29**: YES).

When the recording process (S**14**) shown in FIG. **6** is executed, the controller **130** may execute a feedback control in which the amount of the electrical current supplied to the carriage motor **103** is controlled based on a current location and destination of the carriage **23**, and the pulse signal output by the carriage sensor **38**. However, if the carriage sensor **38** cannot operate correctly, the feedback control cannot be executed. In such a case (e.g., when the reversing process or re-reversing process is executed), an open control may be executed, in which a constant amount of electrical current is applied to the carriage motor **103** by a constant period.

When the open control is executed, it is preferable that the moving amount of the carriage **23** in the reversing process (S**21**) or re-reversing process (S**28**) is the maximum moving amount of the carriage **23** (i.e., the distance between the right end to the left end of the guide rails **43** and **44**). That is, the first current should be supplied to the carriage motor **103** during the period which is a necessary period for the carriage **23** being able to move from the left end to the right end of the guide rails **43** and **44** in the RVS direction. Further, the second current should be supplied to the carriage motor **103** during the period which is a necessary period for the carriage **23** being able to move from the right end to the left end of the guide rails **43** and **44** in the FWD direction.

Since the carriage **23** is moved by the maximum moving amount in the reversing process (S**21**) and the re-reversing process (S**28**), it is ensured that the carriage **23** is moved to the positions to face the waste ink tray **50** or the maintenance mechanism **70**. As a result, the controller **130** can detect a large amount of change in the signal output by the medium sensor **122**, and thus, it is ensured that the controller **130** detects that the carriage **23** has moved.

Further, the amplitude of the first current and the amplitude of the second current is set to small enough so that even if the carriage **23** has bumped the left end or right end of the guide rails **43** and **44** (i.e., further movement is prevented), the carriage **23** may not be broken. Therefore, even if the reversing process (S**21**) or the re-reversing process (S**28**) is executed when the carriage **23** is located at a position as shown in FIG. **3**, breakage of the carriage **23** can be avoided.

In the exemplary embodiment above, the recoding process (S**14**) is described as an example of the carriage moving process. The invention should not be limited to such a configuration, and any process of moving the carriage **23** could be included in the carriage moving process. For example, a process of moving the carriage **23**, in the RVS direction, to the position facing the maintenance mechanism **70** to apply the purge process to the recording head **39** may be included in the carriage moving process. The error notification process shown in FIG. **7** can be executed in any carriage moving process when the pulse signal cannot be obtained from the carriage sensor **38**.

In the embodiment, the error notification process shown in FIG. **7** is executed when the controller **130** cannot obtain the pulse signal of the carriage sensor **38** (S**13**: NO) in the image recording process shown in FIG. **6**. The invention should not be limited to such a configuration. For example, the controller **130** may execute an error inspection process in an inspection process of the MFP **10**. That is, the movement of the carriage **23** to be executed before the error inspection process may only be the movement of the carriage **23** for inspection of the MFP **10**, but not for the image recording process or the purge process.

The error inspection process may include S**12**, S**13** and S**18** shown in FIG. **6**. That is, the controller **130** finishes the error inspection process if the carriage **23** is moved (S**12**) and the pulse signal can be obtained from the carriage sensor **38** (S**13**: YES). If the controller **130** cannot obtain the pulse signal from the carriage sensor **38** (S**13**: NO) after the controller **130** started the carriage **23** to move (S**12**), the controller **130** executes the error notification process (S**18**). It is noted that

the inspection process may be performed when the MFP **10** is made, or when a service person fixes the MFP **10**.

In the exemplary embodiment, the MFP **10** having the inkjet printer **11**, which is an example of the carriage moving device, is described. The invention should not be limited to such a configuration, and the invention can be applied to any other appropriate devices such as a document feeder which conveys and reads a document sheet in an image scanning device.

What is claimed is:

1. A carriage moving device, comprising:

a motor;

a carriage movable in a scanning direction, the carriage moving in a first direction along the scanning direction when the motor rotates forwardly, the carriage moving in a second direction which is opposite to the first direction when the motor rotates reversely;

a facing object configured to face the carriage, the facing object having a plurality of reflection ratios at a plurality of positions in the scanning direction;

a first sensor unit mounted on the carriage at a position where the first sensor unit faces the facing object, the first sensor unit having a light emitting unit configured to emit light to the facing object and a light receiving unit configured to receive light reflected by the facing object, the first sensor unit being configured to output a first signal corresponding to a light amount of the light received by the light receiving unit; and

a second sensor unit configured to output a second signal in response to movement of the carriage;

a controller, which is configured to execute:

a carriage moving process in which the controller controls the motor to forwardly rotate to move the carriage in the first direction;

a reversing process in which the controller controls the motor to reversely rotate to move the carriage in the second direction with controlling the light emitting unit to emit light in response to a condition where a time period during which the second signal cannot be obtained during the carriage movement process; and

a notification process in which the controller notifies an error of the second sensor unit in response to a condition where a changing amount of the first signal in the reversing step exceeds a threshold amount and the controller cannot obtain the second signal.

2. The carriage moving device according to claim **1**, wherein the controller executes:

a re-reversing process in which the controller controls the motor to forwardly rotate to move the carriage in the first direction with controlling the light emitting unit to emit light if the changing amount of the first signal is equal to or less than the threshold amount and the controller cannot obtain the second signal in during the reversing process; and

notifying an error of the motor in the notification process if the changing amount of the first signal is equal to or less than the threshold amount and the controller cannot obtain the second signal during the re-reversing process.

3. The carriage moving device according to claim **2**, wherein the controller notifies an error of the second sensor unit if the changing amount of the first signal exceeds the threshold amount and the controller cannot obtain the second signal during the re-reversing process.

4. The carriage moving device according to claim **2**, wherein the controller:

supplies a first electrical current to the motor to move the carriage in the second direction in the reversing process; and

supplies a second electrical current to the motor to move the carriage in the first direction in the re-reversing process.

5. The carriage moving device according to claim **2**, wherein the controller controls the motor to rotate for a time period corresponding to move the carriage by a distance longer than a movable range of the carriage in the scanning direction during the reversing process and the re-reversing process.

6. The carriage moving device according to claim **1**, wherein the controller notifies that a foreign object exists on a moving path of the carriage in the notification process if the changing amount of the first signal exceeds the threshold amount and the controller obtains the second signal during the reversing process.

7. The carriage moving device according to claim **1**, wherein the controller notifies that a foreign object exists on the moving path of the carriage in the notification process if the changing amount of the first signal is equal to or less than the threshold amount and the controller obtains the second signal during the reversing process.

8. The carriage moving device according to claim **1**,

wherein the controller is configured to supply a constant amplitude of the first current to the motor for a constant period of time in the reversing process; and

wherein the controller is configured to supply a constant amplitude of the second current to the motor for a constant period of time in the re-reversing process.

9. The carriage moving device according to claim **1**, wherein the carriage mounts a recording head configured to eject ink drops to form an image.

10. A carriage moving method employed in a device having a carriage configured to be movable in a scanning direction, the carriage being moved by a motor, comprising:

a carriage moving step of forwardly rotating the motor to move the carriage in a first direction along the scanning direction;

a light emitting step of causing a first sensor unit mounted on the carriage to emit light toward a facing object which has different reflection ratios at different positions in the scanning direction when a second signal which is output from a second sensor unit in association with movement of the carriage in the carriage moving step cannot be obtained;

a reversing step of reversely rotating the motor to move the carriage in a second direction which is opposite to the first direction in the light emitting step; and

a notification step of notifying an error of the second sensor unit when a changing amount of a first signal from the first sensor unit representing a received amount of light emitted by the first sensor unit and reflected by the facing object exceeds a threshold amount and the second signal cannot be obtained.

11. The carriage moving method according to claim **10**,

further comprising a re-reversing step of forwardly rotating the motor to move the carriage in the first direction with causing the light emitting unit to emit light when the changing amount of the first signal is equal to or less than a threshold amount and the second signal cannot be obtained during the reversing step,

wherein the notifying step notifies an error of the motor when the changing amount of the first signal is equal to or less than the threshold amount and the second signal cannot be obtained during the re-reversing step.

12. The carriage moving method according to claim **11**, wherein the notifying step includes notifying an error of the second sensor unit when the changing amount of the first signal exceeds the threshold amount and the second signal cannot be obtained during the re-reversing step.

13. The carriage moving method according to claim 11, wherein:

the reversing step supplies a first current to the motor to move the carriage in the second direction; and

the re-reversing step supplies a second current to the motor to move the carriage in the first direction.

14. The carriage moving method according to claim 11, wherein each of the reversing step and the re-reversing step includes rotating the motor for a time period corresponding to move the carriage by a distance longer than a movable range of the carriage in the scanning direction.

15. The carriage moving method according to claim 10, wherein the notification step includes notifying that a foreign object exists on a moving path of the carriage when the changing amount of the first signal exceeds the threshold amount and the second signal cannot be obtained during the reversing step.

16. The carriage moving method according to claim 10, wherein the notification step includes notifying that a foreign object exists on the moving path of the carriage when the changing amount of the first signal is equal to or less than the threshold amount and the second signal is obtained during the reversing step.

17. The carriage moving method according to claim 10, wherein the reversing step includes supplying a constant amplitude of the reversing current to the motor for a constant period of time; and

wherein the re-reversing step includes supplying a constant amplitude of the re-reversing current to the motor for a constant period of time.

18. A non-transitory computer readable storage device containing instructions which can be executed by a controller of a carriage moving device having a carriage configured to be moved by a motor in a scanning direction, the controller, when executing the instructions, causing the carriage moving device to execute:

a carriage moving step of forwardly rotating the motor to move the carriage in a first direction along the scanning direction;

a light emitting step of causing a first sensor unit mounted on the carriage to emit light toward a facing object which has different reflection ratios at different positions in the scanning direction when a second signal which is output from a second sensor unit in association with movement of the carriage in the carriage moving step cannot be obtained;

a reversing step of reversely rotating the motor to move the carriage in a second direction which is opposite to the first direction in the light emitting step; and

a notification step of notifying an error of the second sensor unit when a changing amount of a first signal representing a received amount of light emitted by the first sensor unit and reflected by the facing object exceeds a threshold amount and the second signal cannot be obtained.

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